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Editorial Comment

Resurgence of Coronary Artery Endarterectomy*

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Diffuse coronary atherosclerosis can impair or prevent surgical treatment by rendering the artery ungraftable or the patient inoperable. Incomplete revascularization may not affect early mortality, but failure to effectively bypass severe arterial narrowing profoundly and adversely affects late cardiac events (1–4). Theoretically, coronary artery endarterectomy could remove atheromatous plaques that compromise arterial runoff. Although the procedure was promoted in the early years of coronary artery surgery, interest in it diminished because of technical problems, high morbidity and mixed results.

In this issue of the Journal, Brenowitz et al. (5) chronicle surgical experiences that feature the early and late results of multiple coronary artery endarterectomies. Since 1978, 25% of their coronary bypass patients received multiple endarterectomies (6). Their article addresses the worst case situation, found in about 3% of their overall series, in which endarterectomy was required for all three major coronary arteries. The mean age of their patients was 56 years, indicating a premature onset of diffuse coronary atherosclerosis, and 10% of these patients had previous coronary bypass surgery. Although 65% of the patients had some evidence of myocardial infarction preoperatively, the mean ejection fraction was 0.54 and only nine patients (6%) had poor left ventricular function. However, all had diffuse coronary atherosclerosis requiring three to seven coronary endarterectomies and an average of five grafts per patient. Their early and 1 year patency rate for saphenous veins grafted to endarterectomized arteries was 89 and 72%, respectively, which was not significantly different from the results obtained after using conventional vein grafts. Moreover, patency was similar whether a proximal, distal or total left anterior descending endarterectomy was performed. Myocardial infarction rates were not significantly different between patients with multiple endarterectomies and patients without endarterectomy. At 5 years 71% survived, and 75% of survivors were symptom free.

Surgical technique. The term endarterectomy means removal of the obstructing atheromatous plaque. In this procedure, the surgeon elevates, dissects out and removes the core of plaque, restoring a normal lumen. In peripheral vascular surgery the arteriotomy is usually closed with a patch of saphenous vein, but in coronary artery surgery the arteriotomy is covered by the end to side graft anastomosis. The technique is generally reserved for the most diffusely atherosclerotic vessels, those in which no lumen is demonstrable or in which the downstream plaque is so diffuse that any progression of disease would shortly impair the effectiveness of a bypass graft placed either at a "window" between plaques or through a mural plaque.

Coronary artery endarterectomy is not applicable for all patients with diffuse, extensive multivessel coronary atherosclerosis. Generally, women receive fewer endarterectomies, probably because of their smaller artery size. The left circumflex system is less likely to become endarterectomized because it is more difficult to effectively clean out; it requires arteriotomy in the main circumflex artery located in the atrioventricular groove and in one or more branches. Fewer endarterectomies are performed in patients undergoing reoperation, especially in arteries already grafted. The endarterectomy cannot traverse a previous bypass anastomosis and must begin distal to that point, or the old distal anastomosis must be dismantled to extract the atherosclerotic core completely.

Complications. The deficiencies of having to resort to endarterectomy are readily apparent. Brenowitz et al. (5) describe a 10% operative mortality rate, 3.8% in 106 low risk and 26% in 38 higher risk patients, which is high by anyone's standards. Perioperative myocardial infarction occurred in 10% and intraaortic balloon pumping was required in 15% of patients. Use of the endarterectomy technique generally precludes internal thoracic (mammary) artery grafting because the smaller arterial graft cannot be sutured easily to an elongated arteriotomy.

Technical requirements for operative success. Endarterectomy of coronary arteries differs from endarterectomy of the peripheral vascular system, such as an internal carotid endarterectomy. Because the coronary vessels are smaller and the plaque more diffuse, success depends on extraction of atheromatous material from numerous side branches in the coronary artery tree. Brenowitz et al. (5) stress the cardinal rule of endarterectomy: all atheromatous material must be removed distal to the arteriotomy site. Complete removal of this material requires meticulous dissection and, in the left anterior descending artery system, either multiple arteriotomies or Johnson's technique of 10 to 15 cm arteriotomies covered by a vein graft. This can be a lengthy undertaking, as indicated by their cardiopulmonary bypass

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time of nearly 6 h, including slightly >3 h of aortic cross clamping. Under these circumstances, outcome is dependent to a great extent on the safety of oxygenator perfusion and myocardial protection.

We believe that cold blood cardioplegia offers the best myocardial protection for complex and lengthy cardiac surgery (7). In coronary artery surgery, emergency procedures, valve and aneurysm combinations and endarterectomy require longer aortic cross-clamp time, and blood cardioplegia has certain advantages: (1) the heart is oxygenated while arrested, (2) the technique allows reoxygenation during replenishment, (3) reperfusion damage is diminished or avoided, (4) blood conservation is enhanced by less hemodilution, and (5) early metabolic recovery is perceptibly stronger than with other techniques. After endarterectomy it is important to perfuse with blood cardioplegia, through both the native circulation and the newly constructed graft.

Long-term results. Removal of the atherosclerotic core potentially opens arteries that are ungraftable. At best, the graft would otherwise be placed at a far distal location or be compromised by impaired arterial runoff. The 5 year results of symptom relief and survival renew hope about the lasting value of coronary artery endarterectomy; however, few late arteriograms are available to substantiate this claim. Today it is more difficult to obtain postoperative coronary arteriograms because asymptomatic patients are reluctant to undergo another catheterization and reimbursement policies are not conducive to restudy. What is not known is the long-term fate of extended arteriotomies to which elongated onlay vein grafts are applied and the relation between the length of time that a coronary artery is totally occluded and the long-term success of endarterectomy with bypass grafting. It may be that after years of complete closure, endarterectomy is a futile procedure. Because slight elevation of cardiac enzyme levels after endarterectomy, often without electrocardiographic change, is not infrequent, it is important to know the effect of endarterectomy on regional left ventricular contraction. There is the possibility that we are trading arterial patency for some myocardial damage.

Antithrombotic therapy. Prevention of thrombosis in grafts and endarterectomized vessels is a determinant of outcome. Antiplatelet therapy is in evolution. Whereas dipyridamole seems to affect platelet behavior on prosthetic graft surfaces (8), the efficacy of combining aspirin and dipyridamole compared with aspirin alone is being challenged. To date, five reports (9–13), two dealing with saphenous vein grafts, have concluded that aspirin alone may be the antiplatelet treatment of choice. Another study (14) indicated that 100 mg of aspirin produced a rise in saphenous vein graft patency rates comparable with the effect of aspirin and dipyridamole. The unresolved question is whether the pediatric dose of 80 mg is absorbed as consistently as 325 mg. Whatever the antiplatelet therapy chosen, it is clear that if any patients are in danger of thrombosis, it is the endarterectomy group, and for that reason, antiplatelet therapy in these patients is indicated whenever possible.

Conclusions. Coronary artery endarterectomy deserves a resurgence, particularly in view of the changing patient population. We are seeing more patients who are elderly, female or diabetic or who have documented peripheral vascular disease. Effective revascularization is impossible in many of these patients without improving arterial runoff. For three reasons, endarterectomy is reemerging as a potentially beneficial technique: 1) better myocardial protection allows the luxury of meticulous dissection and anastomosis; 2) we now know that successful endarterectomy requires *complete* extraction of the atherosclerotic core—a point that Johnson has made for years; and 3) prevention of arterial thrombosis is feasible and will likely improve graft patency after successful coronary artery endarterectomy.

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